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THE MOON.

PHOTOGRAPHED AT THE LICK OBSERVATORY, 1891, OCTOBER 11, 7H., 24M., 29S.-31S. P. S. T.

P U B L I C A T I O N S
O F T H E
Astronomical Society of the Pacific.

VOL. V. SAN FRANCISCO, CALIFORNIA, SEPTEMBER 9, 1893. NO. 31.

PRELIMINARY NOTE ON THE CORONA OF APRIL
16, 1893, OBSERVED AT MINA BRONCES, CHILE.
LONGITUDE, $70^{\circ} 19'$ W; LATITUDE, $28^{\circ} 27'$ S.
ALTITUDE, 6600 FEET.

BY J. M. SCHAEBERLE.

The accompanying photograph of the corona* is made from the fourth of a series of eight negatives taken with a 40-foot telescope on 18 x 22 inch Seed plates, sensitometer No. 26. The duration of exposures and the approximate times after the beginning of totality are as follows:—

No. of Negative.	Exposure Time.	Approximate Times after Beginning of Totality.
1	.25	2
2	2.00	16-18
3	4.00	32-36
4	8.00	50-58
5	16.00	72-78
6	32.00	102-134
7	24.00	148-172
8	.25	186

In the 32^s exposure nearly the whole area of the 18 x 22 plate is covered by the corona. The corona was seen projected on the screen inside of the 40-foot telescope several minutes before

*It is not possible to reproduce the photographs in the present number of the *Publications*.

second contact, and although the last exposure was taken nearly a quarter of a minute after totality, the inner corona and the prominences are conspicuous features of this plate, except where the Sun's limb has burnt out the detail.

The positive copy from the original negative was made by Mr. A. L. COLTON, of the LICK Observatory.

As bearing directly upon the theory of the corona, the photographs taken with five different instruments at the same station show :

First—That, apparently, the matter composing the prominences* and protuberances visible during this eclipse was in orbital motion. In the prominences the matter is distributed with varying density along elliptical arcs symmetrical with reference to the Sun; in many cases these arcs seem to be partially discontinuous; they vary all the way from a normal line to a nearly tangential curve and attain a maximum altitude of about 80,000 miles.

The protuberances visible during this eclipse are shown to be made up of a large number of bright elliptical streams of matter which intersect each other, in projection, at all angles. These streams are so numerous, that, on the smaller scale photographs, this network of lines has the appearance of a continuous surface.

Second—All the remaining visible matter forming the Sun's corona is apparently of a uniform degree of composition and much less dense than the prominences and protuberances, but, as in them, the matter is arranged in the form of (continuous) curved streams of various heights; and each returning stream of the inner corona is plainly visible as a portion of an ellipse whose major axis passes through the Sun's centre, indicating that the matter forming these streams was ejected from the Sun, and is subject to the action of the Sun's gravity. The symmetrical form of these complete arcs (varying again, all the way from a normal line to a nearly tangential stream) indicates that this rare matter suffers practically no resistance to motion due to an atmosphere of the Sun. Structures again, which on the smaller plates appear to follow no law, are, with the aid of the larger plates, shown

*In this note I consider all photographically visible matter exterior to the Sun's surface as forming a part of the corona, and, for convenience of illustration, the higher and conspicuously individual portion of any protuberance is called a prominence; the former, during this eclipse, attained a mean height of about 20,000 miles; while the latter, as conspicuous structures, rose to a maximum height of four times this amount.

to be due to the superposition of these elliptical streams. That these arcs are not due to halation caused by the presence of bright prominences follows from the fact that the eccentricity varies as above stated, and from the further fact that no visible change of form took place with reference to the true place of the Sun during the Moon's transit. These visible returning streams are much the most numerous on either side of the Sun's equator and attain a height of 200,000 miles or more.

Third—The outer corona is mainly caused by more nearly radial streams of matter wholly similar in appearance to the curved returning streams of the inner corona. The various trumpet-shaped outlines so plainly visible on the smaller wide-angle plates are seen to be due to the superposition of individual streams, which, in many cases, can be traced from the Moon's outline on the larger plates to a distance of several solar diameters on the smaller negatives.

In no case have I found the actual structure to be concave towards the Sun's centre, and there are only a few cases of very large streamers having apparently greatly inclined initial directions of motion corresponding to very great velocities, the points of eruption being on or near the Sun's limb. The general form of the outer corona is in general agreement with the prediction for a nearly maximum inclination of the Sun's north pole to the line of sight, although the axis of the inner corona cannot be accurately determined, owing to the condensed state of the projections in the polar regions. Marked extensions (nearly radial) projecting far beyond the usual elliptical outline are found in various quadrants, especially in the north polar regions. I wish to call particular attention to a curious structure near the middle of the fourth quadrant; the head of this comet-like object is about four-fifths of a solar diameter from the Sun's surface; it is visible on all my negatives of the outer corona. On the Dallmeyer negatives of the outer corona the Zodiacial light, (equatorial extension of the corona), shows faintly to a distance of at least eight solar diameters from the Sun.

In my "Mechanical Theory" certain results are deduced for a typical corona produced by streamers uniformly distributed in the spot-zones. Now it is evident that this ideal or perfect form will be the exceptional case, and for the reason that the visible solar disturbances in the two spot-zones differ not only from each other, but also because the study of the Sun's visible surface tells us

that the eruptions are not as a rule distributed with exact uniformity in longitude.

The form resulting from an irregular distribution of the streamers can be constructed, provided the longitudes of the various points of eruption and their distances from the origin are known. As the observer will in general have a less latitude than a given stream, it follows that the normally ejected outgoing matter between the Earth and Sun will, in projection, curve away from the equator on the west side of the Sun, and on the east side the curvature will be towards the Sun's equator, for the reason that the outgoing streams in both the northern and southern hemispheres will be on the east side of the normals. Just the opposite condition of things will exist for the outgoing streams on the farther side of the Sun. (See L. O. *Report on the Eclipse of December, 1889*, Plate VIII). For the incoming streams the inclination is reversed. The resulting form of the corona in any particular quadrant will depend upon the relative amount of ejected matter, in the nearer and farther hemispheres of the Sun's surroundings projected in that quadrant. When the observer is exactly in the plane of motion the stream will coincide with normal in projection.

A streamer is evidently made up of a number of nearly parallel streams of matter having presumably many streams with divergent directions of motion. At great distances from the origin such a streamer projected nearly in the direction of the Sun will, during an eclipse, appear to radiate from a considerable arc of the Moon's limb, the amount and direction of the inclination to the normal being governed by the conditions above indicated.

A considerable interval between two such sets of streamers would result in "gaps" or "rifts" in the corona. When such eruptions actually take place on the Sun's limb, those streamers which have greatly inclined initial directions of motion may evidently also become visible.

Referring now to the coronal photographs of the April eclipse, and numbering the quadrants 1, 2, 3, 4, in the order NE, ES, SW, WN, referred to the projection of the Sun's axis, the observed forms are explained as follows:

In the first quadrant, streams both on this and the farther side of the Sun are seen in projection, with a preponderance of the former. The same distribution will account for the forms in the second quadrant. In the third quadrant the streams of the farther

hemisphere are almost completely eclipsed by those of the nearer hemisphere. Finally, in the first half of the fourth quadrant only the streams of the nearer hemisphere are seen, while the second, or polar half of the same quadrant, has practically the same arrangement as the first half of the first quadrant. The structure in the equatorial regions (giving the appearance of two opposite magnetic poles on the Sun's equator) is in agreement with the theory that the streams of matter are ejected from the spot-zones and are subject to gravitational influences. During this eclipse several powerful eruptions were in action near the Sun's west limb.

A discussion of all the matter available will be embodied in a "Report" on this eclipse, to be subsequently printed.

LICK OBSERVATORY, August 10, 1893.

PHOTOGRAPHS OF COMET *b*, 1893.

BY PROFESSOR W. J. HUSSEY.

During the period of its greatest brightness, I have secured a number of photographs of this comet, using the CROCKER telescope of the LICK Observatory. The objective of this telescope is a portrait lens of nearly 6 inches aperture and with a focal length of about 31 inches. The plates used were 8 x 10 inches, coated with an unusually sensitive emulsion by CRAMER.

The nucleus of this comet is bright and starlike. The coma is dense and nearly circular, having a diameter of about $\frac{1}{4}^{\circ}$. There are very faint extensions of the coma in directions at right angles to the tail. These extensions are short. The tail has been bright. So far as these observations go, it was brightest on the evening of July 13. At that time it could easily be traced more than 12° with the naked eye. In most of the photographs it extends beyond the limits of the plates, and exhibits marked and interesting changes from night to night. Some of these peculiarities will be noted.

Tuesday, July 11, 9^h 00^m to 9^h 20^m. This negative shows the comet with a multiple tail. Four distinct branches proceed from the nucleus, the angle included between the outermost ones being